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Analysing the organic and inorganic nutrient management sources effects on sorghum (fodder)

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Abstract
Sorghum is known as King of Coarse millet of India. It is utilized as feed for cattle. Sorghum produces a large yield and absorbs additional nutrients from the soil. Supplementing only composts just through organic sources weakens soil well-being, increases ecological contamination, and further raises cost of production. Utilization of natural resources to meet the demand for plant supplements is problematic as large amount of natural compost is needed, which is scarce. In this way, the addition of organic sources with chemicals can be used in sorghum which is beneficial. Combined application of incorporates use of natural, inorganic, biofertilizer in crops for accomplishing ideal yield without harming the environment. INM further develops the variables like water holding capacity, fertility of soil and microbes. Combinations of Nutrient Management approaches enhances the grain superiority, stover yield, NPK take-up, yield, soil richness, B: C proportion and net returns of sorghum.

Keywords: sorghum, organic, inorganic, yield, economics

Introduction
In India almost 52-58% of population depend on agriculture (Anonymous 2018) [1]. Combination of organic sources with inorganic sources supplies sufficient nutrients to the plants which can rise the crop produce. This system includes the effective and careful use of all most important plant nutrient sources, including animal manure, compost, green manure, legumes in cultivation systems, synthetic fertilisers in combination with biofertilizers, etc. INM has complex potential to improve plant growth and efficiency of resources while additionally empowering the security of climate and supply quality. A detailed literature review found that INM improves quality of grain, soil health, and viability while increasing crop profits by 8–150% when compared to traditional methods. It also increases water usage productivity and farmer financial returns. It is significant that natural sources which will not provide the entire amount of minerals required for modern agriculture; instead, a systematic use of nutrients is absolutely recommended. The availability of the nutrients is determined by the utilization of natural organic sources and later degradation of all those sources. The use of organic sources and nutrients during the initial harvest significantly increases the yield of crops. (Fence and Dwivedi, 1992) [19].
Sorghum (*Sorghum bicolor*) is known as King of Coarse millet of India. It belongs to the family Poaceae. This class having 25 types of blooming plants as grass. There are 7000 varieties of sorghum around the world (Kangama and Rumei, 2005) [36]. Its origin is Africa and spread all throughout the world. Sorghum is an odd forage crop that uses up higher amount of nutrients compared to other forage crops and needs a lot of nitrogen. (Crawford *et al*., 2018) [17]. It is developed for human utilization and feed for cattle. Sorghum is well known crop of Kharif season and the region in development in India is 2.70 lakh ha & stays green for many days compared to fodder bajra and maize (Anonymous, 2018) [1]. It is utilized for feeding cattle and creation of biofuels and alcoholic beverages India currently has a dry fodder shortage of 21.9 percent, a green feed shortage of 61.1 percent, and a need gap that has to be covered by 3.2% of green forage. (Kumar and Faruqui, 2010) [40]. Despite its low production, sorghum has a larger yield potential than other crops (Singh, *et al*., 2016) [64]. According to (Donald, 2006) [24], in the absence of green feed, it is difficult to sustain animal strength and milk production. Sorghum has an approximate area of about 7.38 million ha in India, produces 7.0 million tonnes annually, and having a production efficiency of 949 kg/ha (DAC, 2012) [20]. According to (Kumar *et al*., 2007) [42], coordinated consumption of all types of nutrients is a method where the combined use of inorganic composts and natural resources has previously gained attention with a need to meet the farmer's benefits on a lasting basis as well as obtaining good environmental conditions.

Integrated nutrient management promotes continued improvement of manure usage abilities and maintains soil productivity and increases yield. (Bejbaruha *et al*., 2009) [7]. Inorganic composts combined with various natural sources of nutrients and bio fertilizers can increase production levels (Roy, 1992) [60]. Bio fertilizers like Phosphate solubilizing Bacteria (PSB) and Azospirillum. Azospirillum is having the ability to build dry fodder and green fodder yield production from 7.8 to 11.3% (Kumar and Sharma, 2002) [41]. According to (Sharma *et al*., 2007) [42], inorganic composts were applied to the harvests if these sources were not able to satisfy the supplement requirement. Suitable utilization of inorganic manures with FYM further develops the soil organic compound, and actual properties and further develops soil efficiency.

Influence on growth and yield of sorghum under combined use of organic and inorganic sources

Sorghum is a dual-use crop and can be used as food for human beings & feed for livestock. Combined application of diversified nutrient sources in sorghum has already shown improvement in grain yield. Applying inorganic nutrient sources with bulky organic manures and biofertilizers like Azospirillum had performed better in sorghum grain giving maximum yield (Kalibhavi *et al.,* 2001) [35]. Diversified nutrient sources along with environmentally sustainable processes has proved to be beneficial in terms of fodder cultivation. The utilization of combined sources of nutrients in intercropping of fodder -grain (sorghum+ chickpea) has yielded maximum dry matter in semi-arid regions of India (Gawai and Pawar, 2004) [27]. Some researchers advocated that application of FYM along with Azospirillum and PSB in combination with 75% RDF and 100% RDF will perform better under the dryland regions of the world. Integrated practice of organic with inorganic nutrient sources is used to increase the organic matter and yield in dryland areas. Gliricidia loppings, nitrogen and compost has shown higher sorghum grain yield than the control treatment. The outcomes show half of the N dose of green gram and sorghum met through ranch-based materials like compost Sharma *et al.,* (2004) [65]. The country's scarcity of green forages and grazing spaces has led to persistent malnutrition in animals, putting their output potential below that of many developed countries. A trail was held at Hyderabad 2005-2009 on fodder cowpea-sorghum cropping system by the application of Nitrogen resulted highest grain yield and dry matter in sorghum and fodder cowpea. Seeds treated with Azotobacter culture combined with nitrogen shown highest yield in sorghum than the application of equal amount of nitrogen without Azotobacter (Sheoron and Rana 2006) [66]. In comparison to RDF alone, Srinivasan and Angayarkanni, 2000) [72] found that by applying combination of organic manures and chemical fertilisers increased nutrient uptake. Highest plant height, total number. Of tillers and dry matter accumulation in wheat was observed by the applying 125 kg N/ha (Chaturvedi *et al.,* 2006) [15]**.** Effect of phosphorous on quality and yield of fodder sorghum was observed by use of residual phosphorous gives more green fodder yield, crude protein and crude fiber content in sorghum fodder (Rashid *et al.,* 2011) [62]. Tillage techniques are used to develop an appropriate seedbed, promote root growth, control weeds, manage crop wastes, and level the soil for nutrient absorption and uniform irrigation (Srivastava *et al.,* 2006) [67]. The development and yield of grain sorghum may be influenced by various tillage techniques along with different INM treatments. The highest dry matter, plant height, B:C ratio is found when recommended dose of nutrients was used with traditional tillage over reduced tillage and minimum tillage in regard to grain production (Yadav *et al.,* 2013) [81]. Using the prescribed amount of nitrogen, phosphorous and FYM shown highest yield in fodder sorghum (Duhan 2013) [25]. Combination of organic nutrients with the chemical fertilizers resulted highest yield in sorghum. Research done at Hayathanagar, Hyderabad, they have applied Farm yard manure with RDF shown more grain yield and stover yield in sorghum (CSH-9) (Tamboli *et al.,* 2013) [77]. Using 20 kg of urea and 15 kg of *Leucaena loppings*, respectively, increased sorghum grain yield by 64% during 2005 and 2006 (Patil, 2013) [56]. It was found that with the use applying higher amount of phosphorous from 0 to 40 kg P_2O_5 ha^{-1} led to higher green fodder yield (Mohan and Singh 2014) [49]. In rainfed regions, productivity might be low because of poor management practices and unpredictable weather. Integrating all approaches through INM is required to enlarge productivity and increase fertility of soil in order to ensure an increased production of high-quality grain. An experiment was conducted in Annamalai University, Annamalainagar on sweet sorghum by the application of RDF, vermicompost, Azospirillium, Phosphobacteria resulted highest yield of grain, dry matter and green stalk yield (Krishnaprabu, S 2014) [37]. Highest plant height recorded by the application of RDF + Azospirillum, an experiment was conducted at forage research station, Anand farming college, Gujarat (Bhuriya *et al.,* 2015) [9]. Accessible phosphorus and nitrogen content didn't shift because of various treatment combinations at the collecting of harvest. Highest green grain yield- 52.8 t/ha, dry fodder yield 13.5t/ha observed when N 25% through vermicomposting + 75% RDN (Singh *et al.,* 2019) [71]. Ideal mixes of chemical and natural supplement sources on Kharif sorghum and rabi chickpea succession for high return in 2013-2015 on Kharif season at sorghum research unit (CRS) ranch, Dr. PDKV, Akola. Use of 25% RDN through FYM + RDN of 75% through synthetic manure + seeds treated with PSB+ Azospirillium to Kharif sorghum and rabi chickpea without RDF is the prevalent treatment for getting yield, efficiency credits and development of individual harvest as well as the framework (Nemade *et al.,* 2017) [55]. Because of low soil moisture levels and inherent soil fertility, crop productivity is low. Although integrated soil fertility management (ISFM) and in-situ rainwater harvesting are promising techniques that can increase crop productivity, their application to sorghum productivity is not yet clear. According to (Kugedera *et al.,* 2018) [45], planting with organic manure had the greatest grain production of 4.40 t/ha of sorghum when compared to conventional tillage and ridges. Using watersheds, such as digging compost pits, enhances crop production. (Patel *et al.,* 2018) [57] Led an investigation on Kharif season 2016 at the agronomy homestead of C.P. School of Horticulture, Gujarat, to learn about the Integrated Nutrient Management of supplement take-up, quality, and green yield of grain sorghum. The use of castor cake/ha 2.0t can build the stem measurement, no. of nodes, leaf stem proportion, and internode length, and it additionally fundamentally expanded the green and dry grain with 15.0 tons Farm yard manure/ha when contrasted with low levels. RDF 100% alongside PSB+ Azotobacter further develops yield credits & development contrasted with half RDF alongside Azotobacter+ PSB. 2.0 t/ha of Castor cake applying recorded higher supplement take-up

(N and P), protein content, supplements accessible to the soil, and lower unrefined fiber content. A balanced use of nitrogen fertilizers and cutting management is fundamental techniques that have been essential for attaining improved crop productivity. Combining of inorganic nitrogen with organic may have increased photosynthetic rate and net absorption rate, which is especially significant for improving the quantity and quality of green biomass in fodder crops. The highest plant height, green fodder yield, dry matter yield in fodder sorghum was observed by the application of 125% RDN (25% RDN through Vermicompost+75% RDN through Urea) (A. A. Giri *et al.,* 2021) [28]. During the Rabi - Summer growing seasons of the years 2017–18 and 2018–19, a field experiment on the chickpea-forage sorghum cropping system was carried out at the Agronomy Farm, Anand Agricultural University, Anand, Gujarat, the highest plant height of chickpea at harvest observed in both the years by the use of RDF 50% + 2t Vermicompost ha-1 + Bio NP (H. B. Sodavadiya *et al.,* 2021) [73]. The highest plant height, Dry matter is observed on integrated nutrient management on pigeon pea by the use of RDF + FYM + sulphur + ZnSO4 + boron (Anoop *et al.,* 2021) [68]. Conducted a field experiment on Rajasthan college of Agriculture, during kharif season 2014 & 2015 observed that by applying vermicompost 5t/ha gives plant height of 61.12 cm and by applying 100% RDF gives dry fodder yield 11.34 of fodder sorghum (Kumar *et al.,* 2022) [38]. By the application of Nitrogen, Phosphorous and potassium on groundnut-wheat-sorghum cropping system the highest yield in fodder sorghum 8196 kg/ha and wheat straw yield 5884 kg/ha (BN Chavda *et al.,* 2022) [14].

Influence on quality of fodder sorghum under combined use of organic and inorganic sources

Fodder sorghum is often used as feed source for livestock. The quality of the fodder can impact the nutritional value of the feed and in turn affect the growth and health of the animals. INM is a system of managing soil fertility and crop nutrient requirement by integrating different sources of nutrients such as organic manures, biofertilizers, and inorganic fertilizers. The use of this system in fodder sorghum cultivation can improve the quality of fodder and provide several benefits. The protein content of the fodder sorghum is a key indicator of its nutritional value for livestock. (Desale *et al.,* 2000) [22] carried out a field experiment at Rahuri, Maharashtra application of the 75% recommended NPK + FYM 10 t ha year-1 to both kharif crops resulted in significantly better crude protein yields per year than all other treatments. As compared to treatments that just received NPK, the treatments that got poultry manure or sheep-goat dung together with 50% of the advised NPK dose had considerably greater levels of N, P, and K content and uptake in cereal forage crops (sorghum, maize, and pearl millet). In comparison to biogas manure and FYM application, poultry manure and sheep-goat manure appeared to be more effective (Vasanthi and Kumaraswamy, 2000) [78]. Fodder sorghum with higher levels of protein can provide a more balanced and nutritious value for livestock. According to (Kalibhavi *et al.,* 2001) [35], there is a relationship between the protein content of sorghum grain and inorganic fertilisers. With the required fertiliser dose, the maximum protein content (11.43%) was found. In comparison to each application alone, the combination of FYM 5 t ha-1, Azospirillum inoculation at 10 kg ha-1, and vermicompost 1.5 t ha-1 recorded higher protein content (10.61%). applying inorganic sources like NPK combined with FYM & vermicompost shown higher crude protein yield of oat (Jayanthi *et al.,* 2002) [31]. Combination of FYM with required amount of inorganic nutrients show increase in amount of crude protein and crude fiber in fodder sorghum (Kumar and Sharma 2002) [41]. Combined use of all integrated nutrients improves quality of crop. Application of 75% NPK + 5 t ha^{-1} Farm yard manure recorded the highest protein content in forage sorghum (9.90%) among the various combinations of organics (FYM, phosphocompost, and poultry manure) and inorganic fertiliser (0, 75, and 100% recommended dose of NPK fertilisers), though they were found to be on par with other organically treated and 100% NPK treated plots (Singh *et al.*, 2015) [64]. The nutrient uptake in forage sorghum was observed by combined use of vermicompost with farm yard manure than the application of RDF (Kumar *et al.*, 2005) [44]. In contrast, applications of 50, 75, and 100% of the prescribed fertiliser dose increased LAI and chlorophyll content in leaves over controls, according to (Ali *et al.,* 2012) [5] analysis of the application of 10 t ha-1 FYM to sorghum.

Influence on soil properties of sorghum under combined use of organic and inorganic sources

A technique through a significant amount of potential might be balanced and sufficient plant nutrition. The ecosystem has been harmed by both the overuse and underuse of fertilizers, as well as by inadequate resource management. Increasing population, land shortages, unfavourable weather patterns, and highly productive technologies have often decreased soil fertility in many Asian and African countries. (Chianu and Tsujii, 2005; Biswas *et al.,* 2006; Ghosh 2015) [16, 11, 29]. A holistic fertilizer management system can maximise the potency of soil, water holding capacity, nutrient levels (Lal 2004; Mahajan *et al.*, 2008) [47,79]. Additionally, fertiliser use causes discharge and overflow of nutrients, particularly nitrogen (N) and phosphorus (P), resulting in environmental deterioration. Compost, biofertilizers, soil, irrigation water, and the atmosphere are all sources of nutrients that increase crop productivity. The nutrients from the soil are removed by crops outpaced their replacement by fertilisers; (Gangawar and Prasad 2005) [26] also found that manures generating unbalanced nutrients in soil. A field experiment was conducted by (Arbad *et al.,* 2008) [3] on sweet sorghum to estimate the effect of chemical fertiliser, organics (vermicompost), Azotobacter biofertilizers and phosphate solubilizing organisms (PSB), and micronutrients (Zn and Fe) on soil properties, green stalk yield, grain yield, and various quality parameters of sweet sorghum (Var. HES-04) on black cotton soils. The results showed that applying vermicompost, biofertilizers alone with 50% of the required amount of fertilisers and micronutrients was beneficial to improving soil well-being and sustaining yield in sweet sorghum growth on vertisols. Robert, 2008 [59] also found that boosting soil fertility and crop efficiency through the use of inorganic fertilisers has frequently had a negative impact on biogeochemical cycles. (Kumar *et al.,* 2009) [43] also discovered that using organic sources in conjunction with fertilisers will undoubtedly increase crop production. The observation on soil pH, EC, OC% and K2O after harvest of the sorghum crop as influenced by combined use of organic sources with synthetic fertilizer treatments. The data showed that when the crop was harvested, the impact of combined nutrient management treatments on pH, EC, OC%, and K_2O soil was determined to be non-significant. The findings on the amount of nitrogen in the soil after the sorghum crop was harvested influenced the treatments for integrated nutrient management. The study revealed that integrated nitrogen management treatments had a major effect on the quantity of N that was available in the soil after the crop was harvested. Significantly greatest available N in soil (225.13 kg ha-1) was recorded by applying (100-40 N-P kg ha^{-1} + Azospirillum). Bio-fertilizers play a critical role in boosting soil fertility by fixing atmospheric nitrogen both with and without the help of plant roots and by creating plant growth material in the soil reported by (Mahdi *et al.*, 2010) [49]. The availability of P_2O_5 in soil after sorghum crop harvest affects combined nutrient management strategies. 100-40 N-P kg ha^{-1} + Azospirillum had the maximum available P_2O_5 in soil (58.29 kg ha^{-1}) resulted in a 13.74% increase in soil accessible P_2O_5 status. Bio-fertilizers perform an important role in lasting soil fertility and sustainability by fixing atmospheric dinitrogen, mobilising fixed macro and micro nutrients, or converting unsolvable P in the soil into forms accessible to plants, increasing their productivity and accessibility (Mahdi *et al.*, 2010) [49]. (Nandapure *et al.*, 2010) [52] expressed that continuous treatment of FYM @ 10 t ha^{-1} in mixture with appropriate doses to sorghum and wheat considerably improved soil physical qualities and maintained crop productivity in vertisol under semiarid circumstances. An integrated strategy for managing soil nutrients must be used in combination with production methods as part of the plan for increasing and keeping crop yields at a high level. (Ghosh *et al.*, 2001; Baishya *et al.*, 2010) [29, 12]. By using 150% NPK the highest porosity 46.85% and particle density 2.53% is observed under sorghum-wheat cropping sequence (S.P Nandapure *et al.*, 2010) [52]. Combined nutrient management solutions should build soil carbon and boost biological methods in order to improve nutrient obtainability and cycle efficiency. According to research findings, neither inorganic fertilisers nor organic fertilizers can result in long-term production (Godara *et al.*, 2012) [30]. Higher soil quality record was seen under coordinated supplement the board of FYM, NPK. Most minimal was in charge (1.14) by half NPK of the suggested portion of compost (1.45) demonstrating an upgrade in soil (Katkar *et al.*, 2012) [34]. The best soil fertility treatment is integrated nutrient management (Chivenge *et al.*, 2011 [18]; Woldesenbet and Tana 2014) [80]. To maintain soil productivity, INM promotes the application of organic, biofertilizers, and synthetic fertilisers in appropriate combination rather than separately (Bagade *et al.*, 2003) [6]. Sweet sorghum was the topic of a field experiment at Annamalai University in the summer of 2009 to examine the effects of inorganic fertiliser, organic manures, biofertilizers, and micronutrients on soil parameters by the application of RDF+ Vermicompost + Azospirillum + Phosphobacteria gave highest organic carbon (Krishnaprabu, S 2014) [37]. Using both organic and inorganic fertilisers together improve the physical and biological assets of the soil while also increasing crop productivity (Shashidhar *et al.*, 1995) [63]. The current study was conducted to investigate the influence of INM on kharif sorghum genotype yield and soil fertility during 2007-08. The experiment was conducted in a factorial randomised block format. Hence, application of 100% RDF was determined to be optimal for increasing grain and fodder yields of sorghum while enhancing fertility status. However, in terms of grain and fodder yield, as well as soil accessible N, P, and K, 7.5 t FYM ha-1 + 50% RDF (T6) was found to be favourable, followed by 100% RDF (Deshmukh *et al.*, 2014) [21]. In forage sorghum, high nitrogen dosage also causes more HCN poisoning. It was considered essential to increase the dose of FYM and nitrogen application. Research led on the field by (Bhuriya *et al.*, 2019) [10] at Anand rural college, detailed that utilization of (N-100, P-40 kg/ha+ Azospirillum) announced most elevated HCN content of sorghum at gather under Gujarat conditions with supporting soil richness. Long terms analysis led to the cropping succession of sorghum and wheat with the objective of surveying persistent utilization of chemical fertilizers by properties of soil and the key pointers are soil quality and yield supportability. The cropping system, which indicates the cropping pattern used on a farm and improves soil health, is a major part of a farming system. In clay loam soils at the Agricultural College Farm, Bapatla, a field experiment was undertaken over two years (2015–16 and 2016–17) to study the residual effects of integrated nitrogen management and cropping systems on soil physical and physico–chemical properties the highest soil pH observed by the application of 100% RDN at harvest in mustard crop (M. Latha *et al.*, 2020) [48]. (Kebenei *et al.*, 2021) [33] performed an experiment on Integrated use of nutrients for Enhanced Soil Fertility and Higher Sorghum productivity in Kitui County, Kenya. According to the study's findings, when used in conjunction with a mix of organic and inorganic amendments, positive effects on vital soil qualities and crop output may be recognised. This could be used as a strategy to increase agricultural production in eastern Kenya and other places that are similar. An experiment was conducted at college of Agriculture, Rajasthan, Udaipur in the year 2014 & 2015 on fodder sorghum-barley cropping system by conductivity bridge (Richards, 1968) [60] method the Electrical conductivity (dS m-1 at 25 °C) is 0.87 and pH (1:2.5 soil: water) is 8.15 (Amit Kumar *et al.*, 2022) [38]. Other relevant soil fertility management practises contain INM, which combines organic and inorganic fertilisers such as animal dung. The combination of rainwater harvesting with INM produces higher sorghum harvests extending from 750 to 2100 kg ha^{-1}, with the potential to increase crop productivity in clay soils (Kugdera *et al*., 2022) [39].

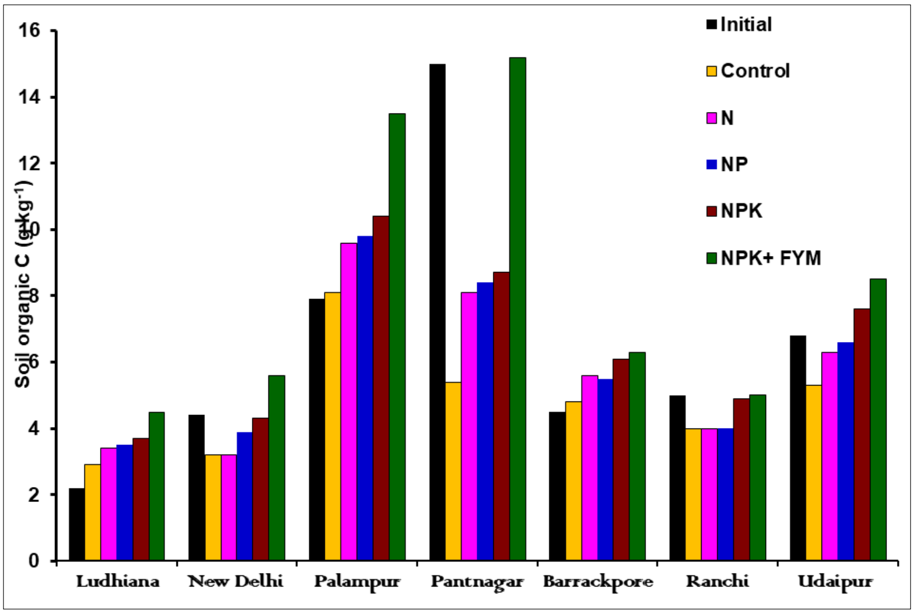

Fig 1: Long term fertilizer trails on soil properties due to INM at different location

Influence on monetary returns of sorghum under combined use of organic and inorganic sources

Application of organic manures like FYM in conjunction with recommended fertilizer rates will provide maximum herbage along with high B:C ratio (Sharma *et al.*, 2009) [70]. He reported that applying of 5 t ha^{-1} in conjunction with the prescribed fertiliser rates or RFR (50:25:00 kg NPK ha^{-1}) resulted in a greater yield (11.58 quintal ha^{-1}) than FYM (7.78 quintal/ha) and RFD (9.77 quintal ha^{-1}) in case of black cotton soils during 2001-2003. Treatment of FYM+RFD resulted in 1.51 B:C ratio than FYM alone. By the application of RDF, the highest plant height at 25 DAS, yield, gross, net-return, benefit-cost ratio than other treatments of INM in sorghum productivity during the 2009 kharif season at Rajasthan College of Agriculture, Udaipur concluded by (Yadav *et al.*, 2012) [81]. He also concluded that in terms of grain yield, RDF was found to be meaningfully greater to reduced tillage and minimum tillage when used in conjunction with conventional tillage. The higher grain and stover yield were obtained by the applying FYM 5t/ha + RDF (50 kg N + 25 KG P/ha) + Zn @10 kg/ha produced the best gross monetary returns (INR 67,147/ha), followed by fertiliser use as per soil test (75 kg N + 31 kg P/ha) + Zn @ 15 kg/ha. Nonetheless, the later treatment produced the maximum net returns (INR 46,342/ha) and B:C ratio (3.37), due to decreased cultivation costs due to the use of organic fertilisers alone. The findings are consistent with previous findings in rabi sorghum published by (Sharma and Kumar 2009) [70]. By using organic manures like farm yard manure, Azotobacter and PSB has already shown higher net returns and B:C ratio in sorghum (Jat *et al.*, 2013) [32]. He also observed that using FYM in conjunction with 100% NPK and co-inoculating with Azotobacter + PSB boosted profit and nutrient uptake under the current agro-climatic conditions. To estimate effects on yield, profitability and energetics of sorghum during rainy season of 2009 and 2010. In comparison to reduced and minimum tillage systems, conventional tillage produced greater grain yields (3.12 t/ha), N, P, and K uptake, and net returns. Usage of the prescribed dose of nutrients was shown to be significantly superior to other treatments in terms of grain yield (3.32 t/ha), net returns, and output energy (Mishra *et al.*, 2014) [51]. By the combination of RDF along with the organic manures on clay soils shown greater financial matters, yield of sorghum- green gram during rabi season (Patil *et al.*, 2017) [57], he concluded that the most extreme net return (RS.59146/ha), impact of yield arrangement (94694 Rs/ha) & summer green gram (35548 Rs/ha) with high benefit-cost proportion (2.42) by the application of bio compost @ 10t/ha + 100 percent RDF through inorganic manures. (Bhagat *et al.*, 2020) [13] revealed the impact of INM on the efficiency, development, and financial profits of vegetables and sorghum-based intercropping frameworks. The research was led in a split-plot plan strategy having eight treatment combinations as intercropping as fundamental plots and three treatment combinations as coordinated supplement the board as sub-plots multiple times initiated. Results uncovered that sorghum, pigeon pea cropping system has resulted increased grain comparable yield, gross income, net income, yield ascribes & B:C proportion of sorghum over different treatment combinations. Use of FYM (5t/ha) with biofertilizer and half of recommended chemical fertilizers had shown most elevated grain, straw, yield attributes, and organic yield of sorghum and furthermore all out grain efficiency, gross income, grain comparable weight, net return over different treatment combinations. B:C proportion was most extreme with the use of FYM(5t/ha), Biofertilizer, and half recommended fertilizers and utilization of RDF for separate yields. In order to ascertain the effects of applying organic and synthetic nitrogen sources to single-cut forage sorghum throughout the summer of 2020, by the application of 100% RDN through vermicompost observed highest cost of farming Rs.66647/ha and B:C ratio 0.68 (Mohammad Nabi *et al.*, 2021) [53]. During kharif season 2017-18 conducted a field experiment at Agronomy Research Farm, Ayodhya, Uttar Pradesh, India based on pigeon pea combined cropping on combination of all nutrients, the highest cost of farming 29278 Rs ha^{-1}, Gross arrival 113454 Rs ha^{-1}, Net return 84176 Rs ha^{-1} and B:C ratio Rs. 2.87 ha^{-1} in pigeon pea + Sorghum intercropping (Yadav *et al.*, 2021) [83].

Table 1: Effect of economics on different crops by using integrated nutrient management

Crop	Treatments	Net returns	B:C ratio	References
Fodder sorghum+ chickpea	25% N through FYM+ 25% N through vermicompost+ 50% N through RDF 100% RDF	22173 Rs/ha 19655 Rs/ha	2.23 2.21	Kumar *et al*., 2008 [43]
Fodder maize	125% RDF	59453.1 Rs/ha	1.68	Subrahmanya *et al*., 2019 [74]
Sorghum	100kg N/ha + 50 kg./ha+ Azospirillium	101316 Rs/ha	2.9	Surve *et al*., 2020 [75]
Fodder sorghum	75% RDN through inorganic source + 25% RDN through FYM	16570 Rs/ha	1.43	Nabi *et al*., 2021 [53]
Rice + berseem	100%NPK+ 10t sesbania ha^{-1}	12808.9 Rs/ha	1.55	Singh *et al*., 2022 [76]

Conclusion

Sorghum (jowar) is a cereal crop and it requires high amounts of supplements than the other feed crops. Use of the compound manures in the harvest won't satisfy its supplement necessity besides harming the soil productiveness and soil well-being. Combined application of diversified nutrient sources is a great methodology intended for the affordable advantage of the farmer also builds the soil richness and supplement accessibility to the yields. By use of divesified forms of organic nutrient sources like natural, chemical, and biofertilizers will expand the development and advancement of the yield. Consolidated use of combined nutrient sources suggests that portion of NPK composts, FYM+ Azospirillum, and different blends build the grain yield, protein content, and supplement take-up of the soil in the sorghum. Rehearsing the these kinds of nutrient management on sorghum stretches fodder yield and quality.

References

1. Anonymous. Package of Practice for Kharif Crops of Punjab, Punjab Agricultural University, Ludhiana; c2018.
2. Acharya CL, Ghosh PK, Subba Rao A. Indigenous nutrient management practices; c2001.
3. Arbad BK, Syed Ismail, Shinde DN, Pardeshi RG. Effect of integrated nutrient management practices on soil properties and yield in sweet sorghum [*Sorghum biocolor* (L.) Moench] in vertisol. Asian Journal of Soil Science. 2008;3(2):329-332.
4. Adane M, Misganaw A, Alamnie G. Effect of Combined Organic and Inorganic Fertilizer on Yield and Yield Components of Food Barley (*Hordeum vulgare* L.). Food Science and Quality Management. 2020;95(1):1-8.
5. Ali M. Integrated Management of Phosphorus and Potassium for Maize (*Zea mays* L.) (Doctoral dissertation, University of Agriculture, Faisalabad); c2012.
6. Bagade R, Ingole PD, Raut BD, Dongore ST, Mohammod S. Effect of integrated nutrient management on yield, uptake of nutrient and quality of rainfed sorghum. PKV Research Journal. 2003;27:44-52.
7. Bejbaruha R, Sharma RC, Banik P. Direct and residual effect of organic and inorganic sources of nutrients on rice-based cropping systems in the sub-humid tropics of India. Journal of sustainable agriculture. 2009;33(6):674-689.
8. Blanco-Canqui H, Lal R. Crop residue removal impacts on soil productivity and environmental quality. Critical reviews in plant science. 2009;28(3):139-163.
9. Bhuriya KP, Mistry GJ, Dharmesh Kumar Prajapathi. Effect of Integrated Nutrient Management on Growth and Yield of Forage Sorghum (*Sorghum bicolor* L. Moench) During Summer Season, Trends in Biosciences. 2015;8(17):475-4758. ISSN 0974-8431.
10. Bhuriya KP, Kharadi RR, Dodiya VC, Kumbhar MB. Effect of integrated nutrient management on HCN (Hydrocyanic acid) content of forage sorghum (*Sorghum bicolor* L. Moench) during summer season. International Journal of Chemical Studies. 2019;7(6):2007-2010.
11. Biswas B, Ghosh DC, Dasgupta MK, Trivedi N, Timsina J, Dobermann A. Integrated assessment of cropping systems in the Eastern Indo-Gangetic plain. Field Crops Research. 2006;99(1):35-47.
12. Baishya LK, Kumar M, Ghosh DC, Ghosh M, Dubey SK. Effect of organic and inorganic nutrient management in potato varieties on nutrient content and uptake, nutrient use efficiency and soil fertility status in Meghalaya hill. Environment and Ecology. 2010;28(3A):1745-1751.
13. Bhagat GJ, Giri DG, Pagar PC, Hadole SS. Effect of Integrated Nutrient Management on Yield Attributes, Yield, and Economics of Sorghum Based Intercropping Systems. International Journal for Current Microbiology and Applied Sciences. 2020;9(6):563-569.
14. Chavda BN, Savalia SG, Mathukia RK, Shitab MS. The impact of long-term manure and balanced fertilization on yield and yield attributes of groundnut, wheat and sorghum on Vertic haplustepts under groundnut-wheat-sorghum cropping system; c2022.
15. Chaturvedi S, Chandel AS. Influence of organic and inorganic fertilization on soil fertility and productivity of soybean (*Glycine max*). Indian Journal of Agronomy. 2005;50(4):311-313.
16. Chianu JN, Tsuji H. Integrated nutrient management in the farming systems of the savannas of northern Nigeria: what future? Outlook on Agriculture. 2005;34(3):197-202.
17. Crawford SA, Shroff JC, Pargi SB. Effect of nitrogen levels and cutting management on growth and yield of multicut forage sorghum [*Sorghum bicolor* (L.) Moench] variety cofs-29. International Journal of Agricultural Sciences. 2018;14(1):118-122.
18. Chivenge P, Vanlauwe B, Six J. Does the combined application of organic and mineral nutrient sources influence maize productivity? A meta-analysis. Plant and Soil. 2011; 342:1-30.
19. Dwivedi AP. Agroforestry Principles and Practices, Oxford & Ibh Publishing Company. New Delhi; c1992. p. 365.
20. DAC. Agricultural Statistics at a Glance. Directorate of Economics and Statistics, Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India; c2012.
21. Deshmukh A, Sonune BA, Gabhane VV, Rewatkar SS. Impact of integrated nutrient management on soil fertility and yield of sorghum genotypes in Vertisol. Agricultural Science Digest-A Research Journal. 2014;34(2):111-114.
22. Desale JS, Bhilare RL, Pathan SH, Patil VS. Effects of manure and fertilizer levels to intensive forage cropping sequences. Journal of Maharashtra Agricultural

Universities. 2000;25(1):18-19.
23. Chandra D, Chandra S, Sharma AK. Review of Finger millet (*Eleusine coracana* (L.) Gaertn): a power house of health benefiting nutrients. Food Science and Human Wellness. 2016;5(3):149-155.
24. Donald MB. Summer annual grasses as forage crops in Albama. Albania operative extension system; c2006.
25. Duhan BS. Effect of integrated nutrient management on yield and nutrients uptake by sorghum (*Sorghum bicolor* L.). Forage Research. 2013;39(3):156-158.
26. Gangwar BG, Prasad K. Cropping system management for mitigation of second-generation problems in agriculture; c2005.
27. Gawai PP, Pawar VS. Integrated nutrient management in sorghum (*Sorghum bicolor*)–chickpea (*Cicer arietinum*) cropping sequence under irrigated conditions. Indian journal of Agronomy. 2006;51(1):17-20.
28. Giri A, Pathan S, Damame S. Effect of Integrated nitrogen and cutting management on growth, yield and quality of summer forage sorghum.
29. Ghosh DC. Integrated Nutrient Management in Potato for Increasing Nutrient-Use Efficiency and Sustainable Productivity. Nutrient Use Efficiency: from Basics to Advances, 343-355. Journal of Chemical Studies. 2019;7(6):2007-2010.
30. Godara AS, Gupta US, Singh RAVINDRA. Effect of integrated nutrient management on herbage, dry fodder yield and quality of oat (*Avena sativa* L.). Forage Research. 2012;38(1):59-61.
31. Jayanthi C, Malarvizhi P, Fazullah Khan AK, Chinnusamy C. Integrated nutrient management in forage oat (*Avena sativa*). Indian J Agron. 2002;47:130-133.
32. Jat MK, Purohit HS, Singh B, Garhwal RS, Choudhary M. Effect of integrated nutrient management on yield and nutrient uptake in sorghum (*Sorghum bicolor*). Indian Journal of Agronomy. 2013;58(4):543-547.
33. Kebenei MC, Muna MM, Nganga FM, Ndungu CK. Zai Technology and Integrated Nutrient Management for Improved Soil Fertility and Increased Sorghum Yields in Kitui County, Kenya. Front. Sustain. Food Syst.; c2021. p. 5.
34. Katkar RN, Kharche VK, Sonune BA, Wanjari RH, Singh M. Long term effect of nutrient management on soil quality and sustainable productivity under sorghum-wheat crop sequence in Vertisol of Akola, Maharashtra. Agroecology. 2012;22(2):103-114.
35. Kalibhavi CM, Kachapur MD, Patil RH. Performance of Rabi Sorghum under Integrated Nutrient Management System. Indian J Dryland Agric. Res & Dev. 2001;16(1):45-50.
36. Kangama CO, Rumei X. Introduction of sorghum (*Sorghum bicolor* (L.) Moench) into China. African Journal of Biotechnology, 2005, 4(7).
37. Krishnaprabu S. Evaluation of vermicompost and biofertilizers on soil properties and yield of sweet sorghum. International Journal of Current Research in Life Sciences. 2014;3(3):191-192.
38. Kumar A. Residual effect of fertility levels, biofertilizers and organic manure on yield attributing parameters in fodder sorghum-barley cropping sequence in southern plain and Aravalli hills of Rajasthan; c2022.
39. Kugedera AT, Kokerai LK, Chimbwanda F. Effects of insitu rainwater harvesting and integrated nutrient management options on Sorghum production. GSJ, 2018, 6(12).
40. Kumar S, Faruqui SA. Forage production technologies for different agro-ecological regions. Tech. Pub. 2010, 1.
41. Kumar S, Sharma BL. Effect of FYM, nitrogen and Azospirillum inoculation on yield and quality of fodder sorghum. Forage Research. 2002;28(3):165-168.
42. Kumar A, Tripathi HP, Yadav DS. Correcting nutrient imbalances for sustainable crop production. Indian Journal of Fertilisers. 2007;2(11):37.
43. Kumar A, Sharma S, Mishra S. Application of farmyard manure and vermi-compost on vegetative and generative characteristics of *Jatropha curcas*. Journal of Phytology, 2009, 1(4).
44. Kumar PO, Nanwal RK, Yadav SK. Integrated nutrient management in pearl millet (*Pennisetum glaucum*)-wheat (*Triticum aestivum*) cropping system. Indian Journal of Agricultural Sciences. 2005;75(10):640-643.
45. Kugedera AT, Nyamadzawo G, Mandumbu R, Nyamangara J. Potential of field edge rainwater harvesting, biomass transfer and integrated nutrient management in improving sorghum productivity in semi-arid regions: A review. Agroforestry Systems. 2022;96(5-6):909-924.
46. Kumar D, Bhati HP, Kumar S, Kumari N, Kumar P. Biosorption of malachite green dye by mycomass and phytomass influence by industrial effluent heavy metals. Invited/Lead Papers.
47. Lal R. Soil carbon sequestration impacts on global climate change and food security. Science. 2004;304(5677):1623-1627.
48. Latha M, Prasad PR, Prasad PRK, Lakshmipathy R, Srinivasarao V. Residual effect of integrated nitrogen management and cropping systems on soil physical and physico-chemical properties. Journal of Pharmacognosy and Phytochemistry. 2020;9(5):1694-1699.
49. Mahdi SS, Hassan GI, Samoon SA, Rather HA, Dar SA, Zehra B. Bio-fertilizers in organic agriculture. Journal of phytology. 2010;2(10):42-54.
50. Mohan S, Singh M. Effect of nitrogen, phosphorous and zinc on growth, yield and economics of teosinte (*Zea Mexicana*) fodder. Indian Journal of Agronomy. 2014;59(3):471-473.
51. Mishra JS, Thakur NS, Singh P, Kubsad VS, Kalpana R, Alse UN, *et al*. Tillage and integrated nutrient management in rainy-season grain sorghum (*Sorghum bicolor*). Indian Journal of Agronomy. 2014;59(4):619-623.
52. Nandapure SP, Sonune BA, Gabhane VV, Katkar RN, Patil RT. Long term effects of integrated nutrient management on soil physical properties and crop productivity in sorghum-wheat cropping sequence in a vertisol. Indian Journal of Agricultural Research. 2011;45(4):336-340.
53. Nabi M, Satpal N, Bhardwaj K, Kharor N. Yield and economics of single cut forage sorghum as influenced by organic and inorganic sources of Nitrogen Under Summer Season; c2011.
54. Naik RVT, Susheela R, Chandrika V, Shanti M, Shashikala T, Suneetha Dev KB. Yield and quality of dual-purpose sorghum-fodder cowpea cropping system as influenced by integrated nutrient management; c2020.
55. Nemade SM, Ghorade RB, Mohod NB. Integrated

Nutrient Management (INM) in Sorghum Chickpea Cropping System under Unirrigated Conditions. Int. J Curr. Microbiol. App. Sci. 2017;6(2):379-385.
56. Patil SL. Productivity of winter sorghum and chickpea as influenced by integrated nutrient management in deep black soils of Bellary region, India. Indian Journal of Soil Conservation. 2013;41(1):52-60.
57. Patil JB, Arvadia MK, Thorave DV. Effect of Integrated Nitrogen Management on Yield, Economics and Soil Properties in Sorghum- Green gram Cropping Sequence under South Gujarat, international journal of chemical studies. 2017;6(1):1098-1102.
58. Patel KM, Patel DM, Gelot DG, Patel IM. Effect of integrated nutrient management on green forage yield, quality and nutrient uptake of fodder sorghum (*Sorghum bicolor* L.). International Journal of Chemical Studies. 2018;6(1):173-176.
59. Roberts TL. Improving nutrient use efficiency. Turkish Journal of Agriculture and Forestry. 2008;32:177-182.
60. Richard LA. Diagnosis and improvement of saline and alkali soils. USDA Hand Book. No. 60. US Govt. Press, Washington, DC; c1954. p. 160.
61. Roy RN. Integrated plant nutrient systems: an overview. Fertilizer, Organic Manure, Recyclable Waste and Biofertilizer, Tendon HLS (Ed.) Fertilization Development and Consultation Organization, New Delhi; c1992.
62. Rashid M, Iqbal M. Response of sorghum (*Sorghum bicolor* L.) fodder to phosphorus fertilizer on torripsamment soil. J Anim. Plant Sci. 2011;21:220-225.
63. Shashidhar BC, Kachapur MD, Chittapur BM, Hunje R. Effect of crop residues on physical, chemical and biological properties of soil in sorghum based cropping systems. In An abstract of seminar on Conservation of Natural Resources for Sustained Production; c1995 November. p. 16-17.
64. Singh K, Joshi YP, Chandra H, Singh DK, Singh R, Kumar M. Effect of integrated nutrient management on growth, productivity and quality of sweet sorghum (*Sorghum bicolor*). Indian Journal of Agronomy. 2015;60(2):291-296.
65. Sharma KL, Srinivas K, Mandal UK, Vittal KPR, Kusuma Grace J, Maruthi Sankar G. Integrated nutrient management strategies for sorghum and green gram in semi-arid tropical Alfisols. Indian Journal of Dryland Agricultural Research and Development. 2004;19(1):13-23.
66. Sheoran RS, Rana DS. Relative efficiency of Azotobacter and nitrogen fertilizer in forage sorghum (*Sorghum bicolor* L. Moench) under semi-arid conditions. Forage Res. 2006;32(2):65-68.
67. Srivastava AK, Goering CE, Rohrbach RP, Buckmaster DR. Engineering Principles of Agricultural Machines, American Society of Agricultural and Biological Engineers; c2006.
68. Sharma A, Singh H, Nanwal RK. Effect of integrated nutrient management on productivity of wheat (*Triticum aestivum*) under limited and adequate irrigation supplies. Indian Journal of Agronomy. 2007;52(2):120-123.
69. Sud D, Mahajan G, Kaur MP. Agricultural waste material as potential adsorbent for sequestering heavy metal ions from aqueous solutions–A review. Bioresource technology. 2008;99(14):6017-6027.
70. Sharma A, Kumar A Effect of organics and integrated nutrient management on productivity and economics of *rabi* sorghum. Karnataka Journal of Agricultural Sciences. 2009;22(1):11-14.
71. Singh KP, Chaplot PC, Sumeriya HK, Choudhary GL. Performance of single cut forage sorghum genotypes to fertility levels. Forage Research. 2016;42(2):140-142.
72. Srinivasan S, Angayarkanni A. Effect of INM on yield and nutrient uptake by rice in STCR experiment. Agricultural Science Digest. 2008;28(2):130-132.
73. Sodavadiya HB, Patel VJ, Sadhu AC. Effect of Integrated Nutrient Management on the Growth and Yield of Chickpea (*Cicer arietinum* L.) under Chickpea-Forage Sorghum (*Sorghum bicolor* L.) Cropping Sequence. Legume Research-An International Journal. 2008;1:6.
74. Subrahmanya DJ, Kumar RAKESH, Pyati PS, Ram HARDEV, Meena RK, Tamta A. Growth, yield and economics of fodder maize (*Zea mays*) as influenced by plant density and fertility levels. Forage Res. 2019;45(2):128-132.
75. Surve V, Singh N, Deshmukh S, Patel TU, Patel DD. Effect of N & P management with and without bio-organics on growth and yield parameters of kharif sorghum under South Gujarat conditions. Journal of Pharmacognosy and Phytochemistry. 2020;9(1):132-136.
76. Singh S, Singh V. Nutrient management in salt affected soils for sustainable crop production. Annals of Plant and Soil Research. 2022;24(2):182-193.
77. Tamboli BD, Bagwan IR, Pawar AB, Bhakare BD, Shelke SR, Kadam JR, *et al*. Integrated nutrient management for sustaining rabi sorghum yield, economics and soil fertility on Inceptisol under dryland condition. Indian Journal of Dryland Agricultural Research and Development. 2013;28(1):70-73.
78. Vasanthi D, Kumaraswamy K. Effects of manure-fertilizer schedules on the yield and uptake of nutrients by cereal fodder crops and on soil fertility. Journal of the Indian Society of Soil Science. 2000;48(3):510-515.
79. Walia V, Mahajan S, Kumar A, Singh S, Bajwa BS, Dhar S, *et al*. Fault delineation study using soil–gas method in the Dharamsala area, NW Himalayas, India. Radiation Measurements. 2008;43:S337-S342.
80. Woldesenbet M, Tana T. Effect of integrated nutrient management on yield and yield components of food barley (*Hordeum vulgare* L.) in Kaffa Zone, Southwestern Ethiopia. Science, Technology and Arts Research Journal. 2014;3(2):34-42.
81. Yadav AK, Singh P, Singh K. Growth, yield and economics of sorghum [*Sorghum bicolor* (L.) Moench] affected by tillage and integrated nutrient management. Forage Res. 2012;38(1):40-43.
82. Yadav AK, Singh P. Effect of integrated nutrient management on yield, protein content, nutrient content and uptake of sorghum [*Sorghum bicolor* (L.) Moench]. Innovative Farming. 2016;1(2):30-34.
83. Yadav A, Kumar N, Ahamad A, Singh HC, Kumar R, Bahadur R, *et al*. Nutrient management in pigeon pea [*Cajanus cajan* (L.) Millisp.] Based intercropping system under rainfed condition of eastern Uttar Pradesh; c2021.